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THE NATIONAL INSTITUTE OF SCIENCE AND TECHNOLOGY: DEVELOPMENT AND TRANSFER OF TECHNOLOGY*

by

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Introduction: Brief History

The National Institute of Science and Technology was established on July 1, 1901 as the Bureau of Government Laboratories (BGL) by Philippine Commission (P.C.) Act No. 156. Although mandated to conduct biological, chemical, and other studies, the main activities of the BGL during this early period were in public health. At that time, diseases such as beri-beri, cholera, diarrhea, dysentery, malaria, and smallpox were prevalent.

On October 26, 1905, the BGL was reorganized and its name changed to Bureau of Science (BS) through P.C. Act No. 1407. The Bureau of Science, through this Act, was mandated to undertake research in all fields of science. In addition, through P.C. Act No. 1519, the Bureau of Science was made the custodian of the international standards of weights and measures in the country.

From 1901 to 1917, the BGL/BS was under the Department of the Interior of the U.S. government - the Philippines being a U.S. colony at that time. But in 1917, it was transferred to the newly created Department of Agriculture and Natural Resources. This indicated a changing role for the Bureau of Science. Greater attention was placed towards making an inventory of the country's natural resources in preparation for its eventual exploitation.

Dr. Paul Casper Freer, head of the Department of Chemistry, University of Michigan was the first superintendent of the BGL in 1901. His title was changed to director when BGL was renamed Bureau of Science in 1905. Three more Americans headed the Bureau of Science: Dr. Alvin Joseph Cox from Leland Standord Junior University (1912-1919); Dr. Elmer Drew Merrill (1919-1924) who later became dean of the College of Agriculture, University of California (Davis) and then director of the New York Botanic Garden; and Dr. William H. Brown (1924-1933). It was only in 1934 when the Bureau of Science had its first Filipino director, Dr. Angel S. Arguelles, a soil chemist.

Soon after the Philippines regained its independence, among the first acts of the Philippine Congress was the passage of Republic Act (R.A.) No. 51, which authorized the President to reorganize the government. The President issued Executive Order No. 94 effective July 1, 1947, converting the Bureau of Science into an Institute of Science and placing it directly under the Office of the President. The Institute of Science was mandated to "make scientific investigations and conduct researches necessary for the promotion and development of industries".

On July 1, 1951, the President issued Executive Order No. 392, renaming the Institute of Science as the Institute of Science and Technology and placed it under the Office of Economic Coordination. By adding the term technology, the President meant to place greater emphasis to the country's industrialization.

On August 23, 1956, Congress passed Republic Act No. 1606 authorizing the establishment of a new scientific body, the National Science Board. The Institute became one of the NSB's agencies and was renamed the National Scientific and Industrial Research Institute.

In 1958, a new Science Act enacted by Congress abolished the NSB and replaced it with the National Science Development Board (NSDB). The NSIRI was renamed, National Institute of Science and Technology (NIST) and placed under the administrative supervision of the NSDB. The head of the NIST was given the title of commissioner and made a member of the governing board of the NSDB. It was mandated to undertake research in all fields of science except nuclear science which was made the responsibility of a sister commission, the Philippine Atomic Energy Commission.

In 1982, Executive Order No. 784, reorganized the NSDB into the National Science and Technology Authority. the NIST became one of the institutes under NSTA and mandated to pursue industrial research and custodian of the international standards of weights and measures in the country.

The NIST today consists of two Centers and three Divisions, namely: the National Research and Development Center (NDRC) which has five research programs: food, microbiological, industrial chemicals, pharmaceuticals, and engineering; the National Standards and Testing Center (NSTC), which has four departments: electronics and acoustics, mechanics and optics, chemistry and biology/toxicology; the Planning and Programming Division (PPD), the Administrative Division, and the Technical Information and Documentation Division (TIDD). Technology transfer activities are directly under the Office of the Director, coordinated by PPD, implemented by NRDC, and documented by TIDD. The Director is appointed by the President of the Philippines and reports directly to the Minister of Science and Technology.

Early Efforts at Technology Transfer

In the early 1900's, beri-beri was a serious disease afflicting pregnant mothers and newborn babies. Pregnant mothers suffered serious cases of edema while babies died at birth, exhibiting a general darkening of the body. Studies showed that the disease was not pathogenic but caused by vitamin deficiency. The Bureau of Science developed a technology for extracting a thick, ill-tasting syrup from "darak" or rice polishing. The syrup was later termed "tiki-tiki" and a tiki-tiki pilot extraction plant was constructed at the BS compound in 1921. The technology was later obtained by a pharmaceutical company and "Tiki-Tiki, Manuel Zamora", the commercial brand name, became very popular in the 1920s and 1930s. Nursing mothers and their babies took daily doses of the ill-tasting syrup.

The technology for making upper leather was transferred to the Philippine industry from the Bureau of Science. In the 1930s, Mr. Marcos Hermoso, the father of the owner of the largest leather processing firm in the Philippines today, Hermoso Hermanos, Inc., was then manufacturing only sole leather using camachile bark for tanning. The researchers in the Upper Leather Research Laboratory, Organic Chemistry Deparment of the Bureau of Science assisted Mr. Hermoso in acquiring the know-how and technology for producing upper leather. The Bureau of Science had a pilot plant that produced leather of such high quality that the leather used in making the shoes of the then President Manuel L. Quezon was produced from the pilot plant.

Recent Efforts at Technology Transfer

In 1965, a lady researcher at NIST's Food and Nutrition Research Center started work on the development of a stable and homogeneous

coconut milk (gata) which can be stored in cans or other suitable containers. Preliminary results were discouraging and work was shifted to other projects.

In February 1969, she and two other researchers had a project approved to develop processes for coconut products. Work on the coconut milk technology resumed. On November 25, 1969, the research group had the following entry in their laboratory notebook, "Got fairly stable product with high acceptability". The technology for producing stable, homogeneous canned coconut milk was developed. In April 1970, the researchers were granted Philippine Patent No. 5632 for the "Process of Preparing Coconut Milk and Product Thereof".

Immediately, efforts were exerted to transfer the technology to the private sector and commercialize the product. Laguna Agro-Industrial Coconut Cooperative (LAICC) agreed to cooperate with NIST to establish a pilot plant to produce canned "gata". A contract was signed on April 26, 1971 between NIST and LAICC stipulating that NIST will supply the technology, machinery, and equipment for the pilot plant while LAICC will provide the land, building, access road, and raw materials for the pilot plant. The plant had a capacity of one tonne per day. The NIST staff fabricated the machines and equipment and supervised the installation. By the middle of 1972, the plant was ready for operation.

Unfortunately, numerous technical, financial, organizational, and marketing problems were encountered during the operation of the pilot plant. The product was not readily accepted in the market and the initial cost of production was high. In addition, a number of organizational changes took place at NIST, contributing to further

delays in the project. After seven years of intermittent operation, the NIST decided in 1979 to lease out the plant to Agro-Gold Food Corporation (AFC) which had expressed interest in expanding and commercializing the operation. In 1983, the corporation employed about 40 workers and produced more than six thousand cases. The plant had been expanded and the corporation is now exporting canned coconut milk using the brand name, Coco Manila.

Another recent effort is the transfer of the design and fabrication technology of a coconut expeller from NIST to Filipinas Foundation, Inc., one of the largest private foundations in the Philippines. For a 3% royalty fee based on gross sales, the NIST has assigned to FFI the right to manufacture and sell the mechanical expeller in the Philippines. The Memorandum of Agreement was signed in 1983 and stipulated that the equipment shall be labeled "NIST-FFI Expeller".

Strategy for Technology Transfer

In spite of its long history and its moderate success in scientific research and technological development, the National Institute of Science and Technology has not been quite successful in its efforts to transfer technology to industry. The four cases described earlier are the only recorded cases of successful transfer of technology over its more than 80 years of existence. It may be further noted that since 1947 the Institute of Science was already mandated to "conduct researches necessary for the promotion and development of industry". In fairness to NIST, however, it must be pointed out that the same thing is true for all government-funded research institutes in the Philippines, i.e. the transfer of indigenous technology seems to be where the institutes are weakest.

The biggest stumbling block in the transfer of indigenous technology appears to be in the failure to establish direct linkage between existing industries and the research institutes. In the absence of this linkage, the research institutes tend to concentrate its efforts on new entrepreneurs. Thus the institutes become saddled with multifarious problems of "pushing" the technology, demonstrating the production process, assisting in organizing the firm that will utilize the technology, helping develop the market, assisting in securing loans, and providing feasibility studies. More often than not, the efforts fail since the institute has no expertise in marketing, feasibility studies, financial analysis, and organization. The entrepreneur, on the other hand, often lacks capital and does not have the logistical support to penetrate the market. The new enterprise, short of capital and with no captive market, eventually fails. If the experience is repeated a number of times, the institute losses credibility, thus further widening the gap between the institute and the established industry.

There are other causes for the loss of credibility by research institutes such as: premature attempt to commercialize a technology that is not yet proven; inability of institutes to sustain a technology transfer effort; and the researchers' hesitance in providing all information needed to insure successful technology transfer.

To establish credibility, the research institute must document cases of successful technology transfer and disseminate the information to industry. The institutes must also minimize the risks of failure by making sure: (i) that the technology being transferred is mature and sufficiently proven; (ii) that a market exists for the product; and (iii) that the recipient is sincerely interested in the technology, has the organization, capital and logistics to support the technology

transfer process, and has the marketing network to distribute the product.

To meet these conditions, the institutes must first attempt to transfer its technologies to existing industries. Thus, a direct linkage between the research institutes and industry is a must. The technology transfer effort must be preceded by a thorough evaluation of the technologies to be transferred and a careful selection of the participating industrial firms. Once a reputation for successfully commercializing technologies is established by the institutes, the biggest bottleneck for technology transfer will be eliminated. Succeeding efforts may venture into higher risk situations; but by then the institutes would have gained the experience, expertise, reputation, and credibility associated with previous successes.

Present Efforts at Technology Transfer

In January 1984, the NIST started assessing the technologies it has developed during the recent years to determine which were "mature" enough for transfer to industry. Seventeen technologies were identified and a brochure entitled NIST Mature Technologies was printed to disseminate the information to the public. Further evaluations were made to select technologies for immediate transfer. The selected technologies met two main criteria, namely: (i) the technology is developed to a level that commercialization will not result in too much technical problems; and (ii) industrial cooperators can be found who will need the technology, will financially support the transfer process, and will push the marketing of the product.

In May 1984, five technologies were selected, namely: (i) an improved alcohol fermentation technology using highly active

flocculating yeast fusant; (ii) accelerated fermentation process for the production of premium quality soy sauce; (iii) improved solar salt making technology; (iv) technology for the production of essential oils from local plants; and (v) a new technology for the production of coconut water beverage.

The first technology involves the use of highly flocculating yeast fusant produced by NIST's microbiological research program. The yeast produces 12% (V/V) alcohol in the beer in less than 24 hours with a conversion efficiency of 95%. Since there are 19 alcohol distilleries in the Philippines which produce an average of only 5-6% alcohol in the beer, the technology, if successfully commercialized will have significant impacts on the distilleries' energy consumption, waste generation, and productivity.

With financial assistance from the ASEAN-Australia Protein Program, the NIST has developed an improved process for the production of premium quality soy sauce. With the use of improved strains of yeast, mold, and bacteria, the fermentation time for the full flavor development of soy sauce has been reduced to 3 months from the usual 8-12 months. The product contains more than 8% protein, surpassing FDA requirements, and contains more lactic acid, an important taste component, than local brands.

It is surprising that while the Philippines has 7,100 islands and is surrounded by oceans it does not produce industrial grade salt. A majority of locally produced salt have high moisture content and are of low purity. Thus, locally produced salt is used mainly in fish sauce (patis) and fish paste (bagoong) production. Industrial salt and table salt are imported.

The NIST has developed its salt production technology by operating a pilot salt farm. The pilot plant has consistently produced good quality salt over a number of years. The salt has low moisture content, low in calcium, magnesium and other impurities, and meets the specifications for industiral and food grade salt.

The fourth technology, the production of essential oils from local plants, fruits, and flowers, has been with the NIST for many years and has become an identifying mark of the Institute. Nonetheless, the technology has not been commercialized. The know-how for extracting oils from tanglad, calamansi, ilang-ilang and others has remained within the confines of the science community. In May 1984, it was decided that this know-how must now be transferred to the private sector and commercialized.

The fifth technology involves the production of a stable, nutritious beverage from coconut water. Coconut water is a waste from the production of dessicated coconut and other coconut-based food products. It constitutes a serious pollution problem when discharged into watercourses due to its high biochemical oxygen demand. Its conversion from waste to beverage (jestingly called Coco-Cola) gives it commercial value and renders unnecessary costly wastewater treatment facilities. Since coconut water biodegrades very readily even with refrigeration, the technology for producing a stable, nutritious beverage with a shelf life of 6-8 months is quite an achievement. NIST developed this technology with financial assistance from the ASEAN-Australian Food Waste Program.

In June 1984, evaluation of various firms interested in the five technologies started and negotiations with selected firms were initiated. A strong commitment to support the program and push the

marketing of the product were major considerations in the selection process.

On August 1, 1984, the NIST Integrated Technology Transfer Program was formally launched using funds provided by the National Science and Technology Authority. The objective: to successfully transfer five NIST-developed technologies to industry.

On August 3, 1984, a Memorandum of Agreement was signed between NIST and Victorias Milling Corporation for the transfer of the alcohol fermentation technology. VMC is the largest sugar mill and refinery in the Philippines producing 60% of the country's refined sugar. It was selected for a number of reasons: (i) VMC has a reputation for technical exellence in the sugar industry; (ii) its distillery, which produces 35,000 liters alcohol per day, supplies the anhydrous alcohol requirement of the government's power alcohol (alcogas: 90% gasoline - 10% alcohol) program; (iii) the distillery has a low fermentation efficiency and produces only 4-5% alcohol in the beer; and (iv) VMC made a very strong commitment to support the effort to its successful completion.

NIST engineers and scientists have been working at the VMC distillery since August 1984. The work plan involves: firstly, monitoring and documentation of the performance of the existing facilities to establish baseline data for future comparison; secondly, use of the NIST yeast fusant in the fermentation process, replacing VMC's yeast strain, but without substantial changes in the facilities and operating procedures; thirdly, use of the NIST yeast fusant and introducing whatever equipment and operational changes are needed to obtain optimum results. After two months of effort, initial results indicate that alcohol yields have increased from the present 5% to 10% without change in the facilities. However, the 10% yield has not yet stabilized.

The second Memorandum of Agreement was signed on September 7, 1984 between NIST and Negros Fisheries Corporation (NEFCOR) for the transfer of technology for the production of industrial grade salt. Organized in 1969, NEFCOR is engaged in aquaculture and salt production. It operates a 70-hectare bangus farm, a 4-hectare prawn farm, and an 8-hectare salt farm.

Over a 7-month period, NIST will transfer its know-how to NEFCOR, and the product will be known as the NIST-NEFCOR Industrial Grade Salt. Since NEFCOR has an existing farm, has technicians already knowledgeable in the rudiments of salt making, and has a ready market for its products, the success or failure of the technology transfer efforts depends mainly on the technical aspects of the project.

On October 4, 1984, the NIST signed a Memorandum of Agreement with Universal Foods Corporation, one of the leading food manufacturers in the Philippines, for the transfer of the soy sauce technology. As in previous agreements, the NIST will send a team to UFC to undertake the transfer of technology; make available to UFC the expertise, including the microorganisms in the production of quality soy sauce; and,conduct testing and analyses of products for quality control. UFC, on the other hand, will: make available to the research team all raw materials and resources needed for the production of soy sauce; provide the assistance of UFC technical and non-technical staff in the implementation of the project; and,take care of the advertisement and marketing of the products. It is also stiuplated that the product label shall state "Process developed by NIST".

UFC has the largest share of the banana sauce (catsup) market in the Philippines. It also sells a limited volume of soy sauce which is produced for them on contract. It will formally enter the soy sauce

market equipped with existing modern processing and bottling facilities, an extensive distribution network, and an established name in the food industry. Again, the technology will be the primary factor in the success or failure of the technology transfer effort. The NIST is confident that the project will succeed since premium quality soy sauce has been consistently produced during the past 1-1/2 years in its own pilot plant. Consumer acceptance has also been established through taste tests and test marketing. UFC, itself, has conducted its own testing and evaluation of the pilot production facilities and the product.

On October 8, 1984, the NIST signed a Memorandum of Agreement with Helen's Pharmaceutical Laboratory (HPL), a small pharmaceutical firm in Cagayan de Oro City in Mindanao, for the transfer of NIST's essential oil extraction technology. HPL manufactures various pharmaceutical products, such as liniments, ointments, tinctures, oils, rubbing alcohol, cough syrup, and others. The essential oil produced from local plants and flowers will be utilized in the formulation of the pharmaceutical products in lieu of imported essential oils. Since it is the essential oil component that is the result of NIST technology and not the product itself, the agreement stipulates that the product label shall carry the statement "NIST Technology in Product Formulation".

The technology transfer implementation of the four aforementioned technologies has not met any major problem so far. The careful choice of technologies to be transferred and the meticulous evaluation of the cooperating industrial firms contributed much to the smooth implementation of the program.

The fifth technology selected for transfer, that is, the

coco-beverage production technology, has however, proved to be quite problematic. Although the selection, evaluation, and negotiation process for industrial cooperators started at the same time, an agreement has not yet been signed for the transfer of the coco-beverage technology.

Initially, the coconut dessicators were thought to be the ideal recipients of the technology since they have the raw materials. By converting waste coconut water into beverage, it is converted into a product of commercial value and costly wastewater treatment facilities are avoided. Unfortunately, pollution control laws are not very strictly enforced in the Philippines for economic reasons. Hence, the dessicated coconut firms have the option of simply providing an inexpensive primary treatment facility and discharging partially treated wastewater into the river. To convert waste coconut water into beverage, the firms have to invest sizeable capital on processing, chilling, pasteurizing, and packaging machines. They also have to establish a distribution network. Since coco-beverage is a new product with no proven consumer acceptance and market size, and since fresh coconut water is readily available at least in the coconut growing areas of the country and in Metro Manila, the dessicated coconut firms are reluctant to make the investment. In addition, they claim unfamiliarity with the consumer products market and the distribution system for beverages.

Since the raw material "producers" were not interested, firms already in the beverage business were considered next. Actually, several inquiries expressing interest on the technology were received by NIST from this sector. Some stated the possibility of export markets in Taiwan and Singapore. After evaluating the interested firms in

terms of their manufacturing and marketing capabilities, the choice was narrowed down to Harman Foods Corporation, a medium sized food company which manufactures an orange-flavored drink in laminated containers. Their product, with the brand name, "Zesto", is very popular in Metro Manila. Since the firm has all the facilities for processing, pasteurizing, packaging, and marketing the product, no additional capital investment is needed for producing coco-beverage. The problem is the source of raw material.

Since Harman Foods is located quite far from the main sources of waste coconut water the cost of transporting the coconut water in refrigerated vans became a problem. After months of grappling with the problem another factory was found not too far from Harman that produces waste coconut water - although in much smaller quantities. Negotiations are now underway for the supply of coconut water and the Memorandum of Agreement with Harman Foods will, hopefully, be signed before the end of October 1984. Initially, 100,000 packages of coco-beverage will be produced to determine market acceptability, both locally and abroad. The long term prospect is that there will be a small market in Metro Manila and the major markets will be in Singapore and Taiwan.

These technology transfer cases clearly indicate the need for careful planning to minimize problems and increase the chance of success. It must be realized that research institutes have limited resources and expertise and therefore they should limit their exposure and responsibility.

If ultimately successful, the transfer of the aforementioned five technologies will provide good case histories. A good cross-section of Philippine industry is represented: from a small firm

like Helen's Pharmaceutical Laboratory; to medium-sized firms like NEFCOR and Harman Foods Corporation; to large firms like Universal Foods Corporation; and to very large firms like Victorias Milling Company.

Conclusion: Future Prospects

The National Institute of Science and Technology is fortunate that during the past year it has received strong support from the Minister of Science and Technology. Support has been given to an integrated citric acid research project aimed at developing an indigenous technology for the production of citric acid from clarified sugar cane juice by submerged fermentation process. The project will reach pilot plant stage in 1985 and Canlubang Sugar Estate, one of the major sugar producers in the Philippines, has formally expressed its interest to cooperate in setting up the pilot plant and commercialize the technology.

The NIST has also received financial support to develop the technology for producing bacteriological grade agar (bacto-agar) from local seaweeds. Marine Colloids, Inc., a company producing semi-refined carragennan (SRC) from seaweeds, has formally expressed interest in the commercialization of the technology once fully developed. Pilot studies on bacto-agar production are scheduled in late 1985.

Contract research with the private sector has been and will be intensified since it provides a mechanism for the immediate transfer and commercialization of research results.

The National Irrigation Administration (NIA), a government corporation, is funding a research project for the utilization of

cashew apple. Since NIA is tasked with the management of two multi-purpose dam watersheds, it has initially planted 3,000 hectares to cashew. While there is no problem marketing the cashew nuts, there is a problem regarding the disposal of cashew apple. NIST is presently studying its use for producing cashew juice, vinegar, and animal feeds. Pilot scale operation is scheduled in early 1986.

Avon Products, Inc., a multi-national pharmaceutical company, is funding a research project with NIST for the production from locally available materials and plants, three ingredients for their products. The NIST-produced products will be used in lieu of imported ones. If successful, Avon plans to set up a small commercial plant to supply its needs, using the NIST-developed technologies.

Other on-going contract research projects that lead to immediate transfer of technology to industry are: technology for producing export quality dehydrated spices for BayMark Corporation; improvement of the technology for producing coconut wine (lambanog) to meet export quality requirements for Camaysa Wine Distillery; technology for the utilization of semi-refined carragenan in the treatment of meat processing wastes and using the sludge as animal feed for Marine Colloids, Inc.; improvement of the existing NIST-developed technology for producing instant bean curd (tokwa) so that it can be used as an ingredient in instant soups, and development of technology for producing fruit leather from local fruits, for the Philippine Refining Company.

In accordance with the "demand-pull" policy enunciated by the Minister of Science and Technology, NIST will devote its resources in the development of technologies responsive to industry "demand", and programs to intensify contract research and technology transfer

will be pursued. The technologies being developed now are future prospects for technology transfer. NIST is aiming to establish a tract record of successfully commercialized research results and become a major factor in the country's industrialization effort.